

UNCLASSIFIED DECURITY CLASSIFICATION OF THIS PAGE (When Date Entered) READ INSTRUCTIONS REPORT DOCUMENTATION PAGE REPORT NUMBER 2. GOVT ACCESSION NO. 3. RECIPIENT'S CATALOG NUMBER First International Symposium on AD-A085 452 Ship Operations, New York, NY TITLE (and Subtitle) A Calculator Program for Mixing Mercator and Great Circle Sailings 6. PERFORMING ORG. REPORT NUMBER N/A CONTRACT OR GRANT NUMBER(*) John G./Ulrich N/A PERFORMING ORGANIZATION NAME AND ADDRESS Defense Mapping Agency Hydrographic/Topographic Washington, D.C. 20315 N/A 1. CONTROLLING OFFICE NAME AND ADDRESS 12. REPORT DATE DMA Hydrographic/Topographic Center 23-25 September 1980 ATTN: PPTD (Tech. Pubs.) 13. NUMBER OF PAGES Washington, D.C. 20315 4. MONITORING AGENCY NAME & ADDRESS(If different from Controlling Office) 15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a, DECLASSIFICATION/DOWNGRADING SCHEDULE DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited. 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) 18. SUPPLEMENTARY NOTES 19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Mercator computation Great Circle computation DEG seconty and identify by block number) 20. ABSTRACT (Continue The Navigation Department, Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) has developed a calculator program, self-contained on one magnetic card, which automatically determines course, distance, and total run in Mercator and Great Circle Sailings. This program will list Great Circle positions every 100 of longitude and then print course and distance for each leg. Labels designating latitudes and longitudes, and program sections are also The entire program is controlled by six label keys and can be shifted

DD 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSC

9

UNCLASSIFIED

CURITY CLASSIFICATION OF THIS PAGE (When Data Entered

NB

20. ABSTRACT (continued)

between Mercator and Great Circle at will. It is prepared on a programmable TI-59 with Marine Navigation Module software and printer capability. The program is in use at DMAHTC for compiling distance tables, and navigational publications and answering public inquiries.

The following data are incorporated in this article: General Information, Mercator Computation, Great Circle Computation, Great Circle Positions Great Circle Course Computation, Program Data, and Special Considerations.

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

UNCLASSIFIED

DAP HIE COBY

A CALCULATOR PROGRAM FOR MIXING MERCATOR AND GREAT CIRCLE SAILINGS

John G. Ulrich
Sailing Directions Branch
Defense Mapping Agency Hydrographic/Topographic Center



Acce	ssion For	
NTIS DDC	G.Zaži MB	Z
	ounced fication_	H ·
Ву		
Distr	ibution/	
Ave i	lability o	cdes
Dist	Avail and, special	or or
Λ		
H		!

Submitted to First International Symposium on Ship Operations

New York City, New York 23-25 September 1980

DISTRIBUTION STATEMENT A

Approved for public release;
Distribution Unlimited

80 6 13 0 48

A CALCULATOR PROGRAM FOR MIXING MERCATOR AND GREAT CIRCLE SAYLINGS

John G. Ulrich
Defense Mapping Agency Hydrographic/Topographic Center

BIOGRAPHICAL SKETCH

The author graduated from Kings Point in 1951, sailed as 2nd and 3rd Mate from 1951 to 1955, and served in the U.S. Navy as navigator from 1955 to 1957. He was employed by the U.S. Naval Oceanographic Office from 1964 to 1972, the Defense Mapping Agency Hydrographic Center from 1972 to 1978, and presently is a Marine Information Specialist in the Navigation Publications Division, Defense Mapping Agency Hydrographic/Topographic Center.

ABSTRACT

The Navigation Department, Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) has developed a calculator program, self-contained on one magnetic card, which automatically determines course, distance, and total run in Mercator and Great Circle Sailings. This program will list Great Circle positions every 10° of longitude and then print course and distance of each leg. Labels designating latitudes and longitudes, and program sections are also shown. The entire program is controlled by six label keys and can be shifted between Mercator and Great Circle at will. It is prepared on a programmable TI-59 with Marine Navigation Module software and printer capability. The program is in use at DMAHTC for compiling distance tables, and navigational publications and answering public inquiries.

The following data are incorporated in this article: General Information, Mercator Computation, Great Circle Computation, Great Circle Positions, Great Circle Course Computation, Program Data, and Special Considerations.

A CALCULATOR PROGRAM FOR MIXING MERCATOR AND GREAT CIRCLE SAILINGS

Introduction

The program was developed in the Navigation Department of the Defense Mapping Agency Hydrographic/Topographic Center for computing distances and Great Circle tracks. It is suitable for programmable calculators with Marine Navigation Module software and printer capability, and will provide Mercator harbor and coastal courses and distances; Great Circle positions, courses, and distances; and total runs from dock to dock. It can be used for any individual sequence or with any combination of Mercator and Great Circle Sailings.

General Information

The overall program was designed on a TI-59 calculator*

(See Fig. 1) with parts of Program 11 (Mercator) and Program 26

(Great Circle), either downloaded and adjusted, or ordered directly from the Marine Navigation Module. With it, the user has the convenience and accuracy of using the module without pressing numerous keys and without reloading repetitive positions. When using the module directly, operators have frequently reloaded such positions incorrectly and have also over-

^{*}Any mention herein of a commercial product does not constitute endorsement by the U.S. Government.

EVAR

run the calculator's computations before it was ready for additional information. With the designed program, after the initial entering of the first position, the calculator is controlled by one or two basic label keys per program section, making it considerably easier to call the correct sequence. All latitudes are parked on the T-register key and all longitudes are situated in the display before initiation of the Sailing sequence. There are 461 locations in the program. Initial programing requires about 1 hour; however, once on a magnetic card, loading requires only 10 to 15 seconds.

All positions are keyed: degrees, decimal (.), minutes, and seconds

Thus, 39°02'N is 39.02

39°02'11"N is 39.0211

39°N is 39 (decimal inferred)

N and W are + (inferred)

S and E are -(+/-key)

Thus, 39.02 +/- displays as -39.02

Mercator

Label keys A' and A are used in the Mercator sequence. A' is used for initiation and only used once; all further positions go directly to A. The last position is repeated for continuity of the program; this is an automatic A' return. Mercator sequence is normally run in degrees and minutes; seconds may be added if more accuracy is desired.

Example:

lst	40°42'N	2nd	40°33'N.
Posit	74°02'W	Posit	74°02'₩.
3rd	40°30'N	4th	40°27'N.
Posit	73°58'W	Posit	73°43'W.

Key as follows:

lst	40.42	Press	x \$	t	
Posit	74.02 in display	Press	2nd	A	
•	40.4200 LAT1				(PRINTED)
	74.0200 LÓ1				•

2nd 40.33 Press x ≠ t

Posit 74.02 in display Press A

74.0200 LO1

40.3300 LAT2

74.0200 LO2

180.00 CO

9.00 MI (PRINTED)

9.00 TOT

40.3300 LAT1

ballon of flari

3rd 40.30 Press x \$ t

Posit 73.58 in display Press A

40.3000 LAT2

73.5800 LO2

134.62 CO (PRINTED)

4.27 MI

13.27 TOT

40.3000 LAT1

73.5800 LO1

4th 40.27 Press x \$ t

Posit 73.43 in display Press A

40.2700 LAT2

73.4300 LO2

104.73 CO

11.80 MI (PRINTED)

25.07 TOT

40.2700 LAT1

73.4300 LO1

Course and distance are therefore given for each leg and total distance is maintained throughout.

حق دارد خدر براه در	Transition considerate the second con-	P COT !	
	40.4200 74.0200	EATI	
Bergadyaaskapun (m. abrott fysis) ja ja ab. — hagdirlik (m. gaar), sessaalus	40.3300	AND TO A STATE OF THE STATE OF	annonne de la destre e ser est que sem sus semanos partires de la companya de la companya de la companya de la
	740200		
	64.0200	1961	
	180.00	CD = 1	
	9.00.	Mi	
			
		H. The Late of the	· · · · · · · · · · · · · · · · · · ·
•	180-00= 9:00 v	The state of the s	
	40.3300	-ELATI	gerganistika kan samilika kan kata ka ka katalaga samiganistika
	74.0200	LOI	
	_40,3000	⇒EAT2	Marketine and the second secon
	73.5800		
Annales and a second se	and the state of t		
		CO	
ATTEMPT 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	4.27	MI	### ## ### ###########################
**************************************	13. 27	TOT	
A state of a company can be upon a company of	·		
	40 0000	074	•
ente annume d'ampartui e que el el 2000 con 193	40.3000 73.5800	LATI LOI	particular control of the control of
	40. 2700	LAT2	
المربوط نید به در در د	73.4300	LO2	Antonia e constant a dispersión de la constantia del constantia della cons
-			
	104_73 111.80	COS	
•	25.07	MI	
	VIII		
			
	~40 1 2200	PLATI	•
	73.4300	SEARCH COM	

Great Circle

Label keys C and C' control the Great Circle sequence; C is used for the initial departure; C' is used for the arrival position. The last position of the Mercator sequence is auto-

matically entered if the user wishes. All Great Circle positions are run in the four-digit mode but still entered in the two-digit degree, decimal (.), minute mode.

Example: New York to Capetown (See Fig. 2)

Dep: 40°27'N Arr: 33°51'S

73°43'W 18°15'E

40.2700 - Still in

73.4300 calculator memory

Press C

GRT CIRCLE

4027.00 (PRINTED)

7343.00

Arr: -33.51 Press x ≠ t

-18.15 in display Press 2nd C

-3351.00

-1815.00

6751.46

(PRINTED)

6776.53 TOT

-33.5100 LAT1

-18.1500 LO1

-10.1300 FO

Full Printout of Great Circle Example

a subtract the second residence of the second residence of the second se	CONTROL OF THE SECRET OF THE S	
	GRI CIRCLE	
\$100 to \$200 \$100 to \$200 \$200 \$100 \$100 \$100 \$100 \$100 \$100		
	7643200	
بريهون فياليندها التراب والإساد بيناديكينية الاستثنائة المتكاندة المتكاددة المتكاددة		
The second secon	6751246	
the statement of the st	6776.53	
The second secon		•
	-3365100 ELATI4	
	-3355100 FEERI 14	
	primary and a facility of the control of the contro	

The figure immediately below the arrival position is the Great Circle distance; the total is the Great Circle distance added to the total of any preceding Mercator distances.

At this point the user may either return to Mercator to his final destination, to another Great Circle, or he may call for the positions on the above Great Circle example.

Great Circle Positions

All Great Circle positions are run in even 10° of longitude in the direction the user wishes to proceed. The normal sequence is 6 positions but by pressing SBR twice, the number of Great Circle positions may be increased to 13. This may be done before doing the initial Great Circle work and will show in the display at the end of the Great Circle sequence.

The initial Great Circle position was: 40°27'N. 73°43'W.

Enter even longitude divisable by 10, the next such meridian in direction of arrival. This must show in the display. No decimal is required.

Thus: 70 i	n display	Press E	
	en general de de la composition della compositio		
	GRT CIRCLE	POS	
	7000.1000 3858.173	00	 -
	6000.00 3403.68		
	5000.00 2735.00		
	4000.00 1926.27		
	3000: 00 947: 73	89	***************************************
application of regularization of the second	2000.00 -44.14	00 (1) 78 (2)	

nover the Alexandrian space of the second spac	îsi)	· <i>J</i>	9
an in the second se	Trademagn and any and any and	1000.0000	-
and the second of the second o	The object was desired to the object of	-1111.7944	
		0.0000	
- militaris in control and a supplementa an again, in	t f Minuson typ agg.m unstraintu Afrika.	-2039. 4789	
		-1000.0000	
		-2834.5289	
	en e	-2000:0000	
er sammer for hard errorrorrorrorrorrorrorrorrorrorrorrorro		-3449.6789	
		-3000.0000	
		-3932. 7567	
The second in the second representation of the second seco	· result described and a second	-4000.0000 -4256.3633	
		-4230. 3033	
		-5000.0000 -4512.1978	
-		•	
. 			
		-33.5100 LAT1 -18.1500 LO1	
in the second definition of the second design of th	and the second s	A TOTAL TOTA	

The last three positions are beyond the arrival position but still part of the same Great Circle. As can be seen, the longitude is on top and the latitude on the bottom. The four decimal places are for accuracy; all numbers to the right of the decimal are decimal minute. Therefore, 3858.7344 is read as 38°58.73'N.

Great Circle Courses

The calculator will recall each of the Great Circle positions and automatically print out the Mercator course and distance for each leg. The total distance is reset to 0 for these calculations and not added to the original totals. courses are called by D' (2nd D). No other input is required.

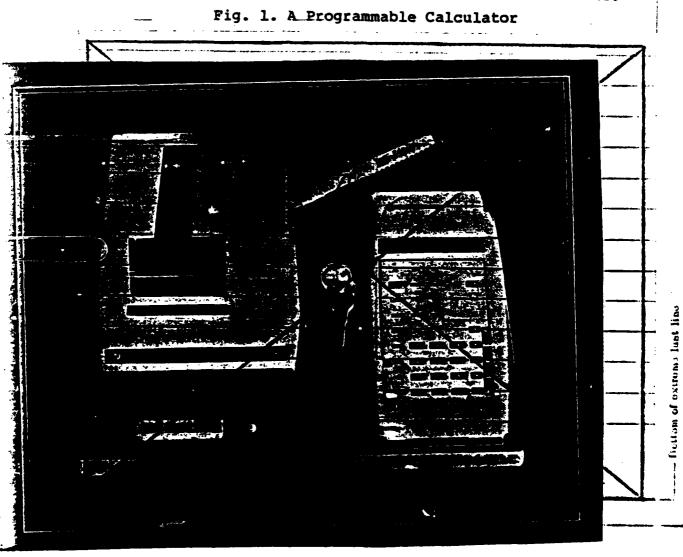
Press 2nd D

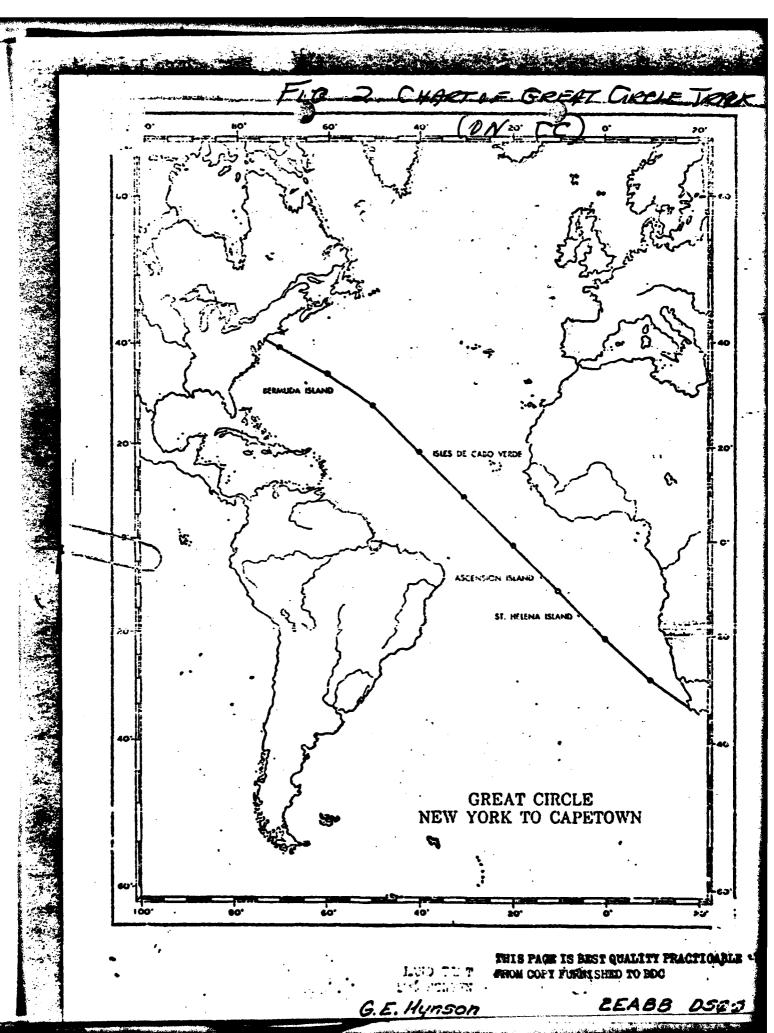
Partial Run of Great Circle Courses

	GRT CIRCLE	e co			
*	GRI CINCE				
ing sample of the sample of th	40.2700	LAT1			
	73. 4300	LO1			•
	38.5844	LAT2	, .	يرداو دانواد فسادانسا المحاد	
Section of the sectio	70.0000	L02			
	117.23	Ç <u>u</u>			
· · · · · · · · · · · · · · · · · · ·	192.91 192.91	MI		a - 1 10 m may a halfan a	:
		and the second		r i 10 verdiffigide flore state upo engine del	;
-	38. 5844	LAT1	i i magamassass		
ing and a single control of the cont	70.0000 34.0341			er e e e e e e e e e e e e e e e e e e	
made companies de la decidad de la companies de	60.0000	L02 %)	- 17 Str. 1 St State of State	
•• •• • • •	121.48 565.03	CO MI		e a salena - proprieto de se	sunugaran .
,	757. 94	TOT			

Butters of complete bond and

	. 3	, j ,,,
	11	
34-8341 EAT	A 4	
60.0000 KLD	Tel	
27.3500 LAT	<u> </u>	,
50.0000	2 4	3
127-05		11 1.
		Th.
1-140219371 4: [0]		n of
		tto
		ă 🤔
27:3500 2/2EAT		
Sur ouud Akaren		*
· · · · · · · · · · · · · · · · · · ·	THIS PAGE IS BEST QUALITY PRACTICAL FROM COTY FUT MISHED TO DDC	BL₃





Sotton of lively have

•	
transmitted to the second of t	and the second s
the state of the s	Constitution to the contract of the contract o
ng ang gada sahaga nakilga nagar ang panalan. Na kunan gilikinin palaggan agal daga daga daga daga nagan sa an	man an index minimizer and it can be an interesting that the large of the second of the second distribution of the second distrib
	e supplication parties at the second provided in the second parties of the second partie
under mannen anderskriger brooks verderliker som i silve var i appelære der fræderingskrive der med fagger i de	annual sa ann an ann an an an an an an an an an
	The state of the property of the first state of the property of the state of the st
and the second s	e de la company
and a submitted program of the subsection of the	· · · · · · · · · · · · · · · · · · ·
المتعصد المتعدد والعواد المنوي والدائد المتعدد والوسطون والمعدد والمتعدد وا	and the second s
and the second s	A company of the comp
and the second s	The second secon
en de la companya de La companya de la companya del companya de la companya del companya de la c	e de magazinas (a como como consentante de la questra como consentante de magazina de la como como como como como como como com
Andrew Company and the Company of th	The second section of the second second section of the second second second second second second second second
production and the second section of the section of the second section of the section of the second section of the section of th	
e fragment filing to the supplicate gauge of the same of control file supplicate and produce and the supplicate and the supplic	and the second s
Contact in the model field degree is a first on the contact to the	to the street, the street of t
The consideration of the second of the second of the consideration of the second of th	
ويقطعوا بيسوا بالمعادر ويقطعون والعامل والمعادر	the constraint of the second of the constraint o
	<u>, in the second second</u>
	,

Fig. 2. Chart of Great Circle Track

000 76 LBL				,		•						
001 16 A' 046 06 06 091 43 RCL 002 98 ADV 047 22 INV 092 18 18 9 003 98 ADV 048 158 FIX: 093 22 INV 004 32 XIT 049 92 RTN 094 77 EE 005 22 INV 050 76 LBL 095 17 B. 006 58 FIX 1050 11 A 096 6E GTD 007 42 STD 095 17 B. 008 04 04 04 053 42 STD 098 077 07 099 88 DMS 055 42 STD 098 077 07 099 88 DMS 055 42 STD 100 76 LBL 011 02: 02 02 056 24 24 100 76 LBL 011 02: 02 057 88 DMS 102 85 4 100 76 LBL 012 02: 02 056 24 24 100 36 66 60 00 00 00 00 00 00 00 00 00 00 00		000 *	76 "LB	L TOTAL	773 m 475 m 4 m	0457	fég :	ne Mari	. The stagewasting	กิจก	100mm2000	
002 98 ADV 047 22 INV 092 18 18 903 98 ADV 048 158 FIX 093 22 INV 004 32 XIT 049 92 RIN 094 77 16 E				_		046	.06	06				
004 32 X1T				v l		047	\$22	TNV				
005 22 INV 055 76 LBL 095 17.8! 006 58 FIX 055 32 XIT 097 017 01 008 04 04 04 055 32 XIT 097 017 01 008 04 04 04 055 42 SID 098 07 07 07 099 88 DMS 055 42 SID 098 07 07 07 099 88 DMS 055 42 SID 100 76 LBL 011 02 02 02 056 24 24 101 17.8 012 02 02 056 24 24 101 17.8 012 02 02 056 24 24 101 17.8 013 034 3 014 011 1 059 21 21 104 066 6 015 03 3 060 02 2 105 00 0 0 016 03 3 060 02 2 105 00 0 0 016 03 3 060 02 2 105 00 0 0 016 03 3 060 02 2 105 00 0 0 016 03 3 060 02 2 105 00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0						N48	558	FIX		093	22 TNU	2
005 22 INV 050 76 LBL 095 17 B						049.	392	RTN		094	77 CF	-
006 58 FIX					7				ية به جان عاد ر	095	: 1:7:-P	- 1
007					A POST	0515	7.1 I	A CONTRACT		096	CALCIT	
009						052	32	XIT		097	nt #-n1	
009 88 DMS		008	04.0	4 3 6	N A	* 053£	42	STO		098	กรากร	
010 42 \$10		009	.88. DM	S.	77.48	:054.5	2.04 ⋅	. ∩4*::- l		099.	::9211RTN	
012 02 2		010*	42°ST			055	42	STOF		ាលព	*76 T RI	
012 02 2		011	<u> </u>	2	-104	056	- 24	24		101	17-B	
013		012	₹02*†2							102		·, · · · ·
019 02 2 064 03 3 109 18 18 020 71 SBR 065 07 7 110 01 1 021 52 EE 066 00 0 111 05 5 022 32 X1T 067 03 3 112 03 3 023 42 STD 068 71 SBR 113 02 2 024 04 04 04 069 52 EE 114 69 UP 025 88 DMS 070 32 X1T 115 04 04 026 42 STD 071 42 STD 116 43 RCL 027 03 03 072 04 04 117 18 18 028 02 2 073 42 STD 118 69 UP 029 07 7 074 25 25 119 06 06 030 03 3 075 88 DMS 120 03 3 031 02 2 076 42 STD 121 00 0 032 00 0 077 22 22 122 02 2 033 02 2 078 02 2 123 04 4 034 71 SBR 079 07 7 124 69 UP 035 52 EE 080 03 3 128 69 UP 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 080 03 3 128 69 UP 039 69 UP 084 71 SBR 129 06 06 040 04 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NUP 042 04 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24		013~	:02:27	main de les		ି 058	42	STO		103	¥03¥4-3 ·	
019 02 2 064 03 3 109 18 18 020 71 SBR 065 07 7 110 01 1 021 52 EE 066 00 0 111 05 5 022 32 X1T 067 03 3 112 03 3 023 42 STD 068 71 SBR 113 02 2 024 04 04 04 069 52 EE 114 69 UP 025 88 DMS 070 32 X1T 115 04 04 026 42 STD 071 42 STD 116 43 RCL 027 03 03 072 04 04 117 18 18 028 02 2 073 42 STD 118 69 UP 029 07 7 074 25 25 119 06 06 030 03 3 075 88 DMS 120 03 3 031 02 2 076 42 STD 121 00 0 032 00 0 077 22 22 122 02 2 033 02 2 078 02 2 123 04 4 034 71 SBR 079 07 7 124 69 UP 035 52 EE 080 03 3 128 69 UP 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 080 03 3 128 69 UP 039 69 UP 084 71 SBR 129 06 06 040 04 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NUP 042 04 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24		01.4	-01.51			059.	《21	21	-	104	-06-3-6	
019 02 2 064 03 3 109 18 18 020 71 SBR 065 07 7 110 01 1 021 52 EE 066 00 0 111 05 5 022 32 X1T 067 03 3 112 03 3 023 42 STD 068 71 SBR 113 02 2 024 04 04 04 069 52 EE 114 69 UP 025 88 DMS 070 32 X1T 115 04 04 026 42 STD 071 42 STD 116 43 RCL 027 03 03 072 04 04 117 18 18 028 02 2 073 42 STD 118 69 UP 029 07 7 074 25 25 119 06 06 030 03 3 075 88 DMS 120 03 3 031 02 2 076 42 STD 121 00 0 032 00 0 077 22 22 122 02 2 033 02 2 078 02 2 123 04 4 034 71 SBR 079 07 7 124 69 UP 035 52 EE 080 03 3 128 69 UP 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 080 03 3 128 69 UP 039 69 UP 084 71 SBR 129 06 06 040 04 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NUP 042 04 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24		015	• 03÷ ; 3	man din dina		- 060 -	₹02	. 2:☆/` }	-	105	00 * 0	
019 02 2 064 03 3 109 18 18 020 71 SBR 065 07 7 110 01 1 021 52 EE 066 00 0 111 05 5 022 32 X1T 067 03 3 112 03 3 023 42 STD 068 71 SBR 113 02 2 024 04 04 04 069 52 EE 114 69 UP 025 88 DMS 070 32 X1T 115 04 04 026 42 STD 071 42 STD 116 43 RCL 027 03 03 072 04 04 117 18 18 028 02 2 073 42 STD 118 69 UP 029 07 7 074 25 25 119 06 06 030 03 3 075 88 DMS 120 03 3 031 02 2 076 42 STD 121 00 0 032 00 0 077 22 22 122 02 2 033 02 2 078 02 2 123 04 4 034 71 SBR 079 07 7 124 69 UP 035 52 EE 080 03 3 128 69 UP 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 080 03 3 128 69 UP 039 69 UP 084 71 SBR 129 06 06 040 04 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NUP 042 04 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24		016	. 03 - 3			061	707	7		106	` 95 ⁻ # = -	
019 02 2 064 03 3 109 18 18 020 71 SBR 065 07 7 110 01 1 021 52 EE 066 00 0 111 05 5 022 32 X1T 067 03 3 112 03 3 023 42 STD 068 71 SBR 113 02 2 024 04 04 04 069 52 EE 114 69 UP 025 88 DMS 070 32 X1T 115 04 04 026 42 STD 071 42 STD 116 43 RCL 027 03 03 072 04 04 117 18 18 028 02 2 073 42 STD 118 69 UP 029 07 7 074 25 25 119 06 06 030 03 3 075 88 DMS 120 03 3 031 02 2 076 42 STD 121 00 0 032 00 0 077 22 22 122 02 2 033 02 2 078 02 2 123 04 4 034 71 SBR 079 07 7 124 69 UP 035 52 EE 080 03 3 128 69 UP 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 080 03 3 128 69 UP 039 69 UP 084 71 SBR 129 06 06 040 04 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NUP 042 04 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24		0171	: 07 - 7		karangan Pangan Kanangan	062	01	1		107	98 ADV	
022 32 X;T						063	03	3				
022 32 X;T				_	,	064	03	3 ~			18 18	
022 32 X;T				K.		065	U/	7 (01 - 1.	- ·
023 42 STU 068 71 SBR 113 02 2 024 04 04 069 52 EE 114 69 UP 025 88 DMS 070 32 X T 115 04 04 026 42 STU 071 42 STU 116 43 RCL 027 03 03 072 04 04 117 18 18 028 02 2 073 42 STU 118 69 UP 029 07 7 074 25 25 119 06 06 030 03 3 075 88 DMS 120 03 3 031 02 2 076 42 STU 121 00 0 032 100 0 077 22 22 123 04 4 034 71 SBR 079 07 124 69 UP 035 <td></td> <td></td> <td></td> <td>-</td> <td></td> <td>066</td> <td>υU</td> <td>ŭ l</td> <td>•</td> <td></td> <td></td> <td></td>				-		066	υU	ŭ l	•			
024 04 04 04 069 52 EE 114 69 UP 025 88 DMS 070 32 X;T 115 04 04 026 42 STU 071 42 STU 116 43 RCL 027 03 03 072 04 04 117 18 18 028 02 2 073 42 STU 118 69 UP 029 07 7 074 25 25 119 06 06 030 03 3 075 88 DMS 120 03 3 031 02 2 076 42 STU 121 00 0 032 00 0 077 22 22 122 02; 2 033 02 2 078 02 2 123 04 4 034 71 SBR 079 07 7 124 69 UP 035 52 EE 080 03 3 125 04 04 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 083 03 3 128 69 UP 039 69 UP 084 71 SBR 129 06 06 040 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NUP 042 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24												
025 88 DMS	٠.											
026 42 STU 071 42 STU 116 43 RCL 027 03 03 072 04 04 117 18 18 028 02 2 073 42 STU 118 69 UP 69 09 029 07 7 074 25 25 119 06 00 07 22 22 122 02 2 123 04 4 04<									,			
027 03 03 072 04 04 117 18 18 028 02 2 073 42 STD 118 69 DP 029 07 7 074 25 25 119 06 06 06 030 03 3 075 88 DMS 120 03 3 031 02 2 076 42 STD 121 00 0 0 032 00 0 077 22 22 122 02 2 033 02 2 078 02 2 123 04 4 034 71 SBR 079 07 7 124 69 DP 035 52 EE 080 03 3 125 04 04 04 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 083 03 3 128 69 DP 039 69 DP 084 71 SBR 129 06 06 06 040 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NDP 042 04 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24												
028 02 2 073 42 STU 118 69 IP 029 07 7 074 25 25 119 06 06 030 03 3 075 88 DMS 120 03 3 031 02 2 076 42 STU 121 00 0 032 00 0 077 22 22 122 02 2 033 02 2 078 02 2 123 04 4 034 71 SBR 079 07 7 124 69 IP 035 52 EE 080 03 3 125 04 04 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 083 03 3 128 69 IP								-				
029 07 7. 074 25 25 119 06 06 06 030 03 3 075 88 DMS 120 03 3 121 00 0 0 032 00 0 077 22 22 122 02 2 033 02 2 078 02 2 123 04 4 034 71 SBR 079 07 7 124 69 DP 035 52 EE 080 03 3 125 04 04 04 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 083 03 3 128 69 DP 039 69 DP 084 71 SBR 129 06 06 06 040 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NDP 042 04 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24										118	69 NP	
030 03 3 075 88 DMS 120 03 3 3 031 02 2 076 42 STO 121 00 0 0 032 00 0 077 22 22 122 02 2 123 04 4 034 71 SBR 079 07 7 124 69 OP 035 52 EE 080 03 3 125 04 04 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 083 03 3 128 69 OP 039 69 OP 084 71 SBR 129 06 06 06 040 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NOP 042 04 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24									•			
031 02 2 076 42 STU 121 00 0 0 032 00 0 077 22 22 122 02 2 123 04 4 034 71 SBR 079 07 7 124 69 UP 035 52 EE 080 03 3 125 04 04 04 037 76 LBL 082 00 0 127 15 15 038 52 EE 083 03 3 128 69 UP 039 69 UP 084 71 SBR 129 06 06 06 040 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NUP 042 04 04 08 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24												
032 00 0 077 22 22 122 02 2 033 02 2 078 02 2 123 04 4 034 71 SBR 079 07 7 124 69 0P 035 52 EE 080 03 3 125 04 04 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 083 03 3 128 69 0P 039 69 0P 084 71 SBR 129 06 06 06 040 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NOP 042 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24												. *
033. 02 2 078 02 2 123 04 4 034 71 SBR 079 07 7 124 69 0P 035 52 EE 080 03 3 125 04 04 04 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 083 03 3 128 69 0P 039 69 0P 084 71 SBR 129 06 06 06 040 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NOP 042 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24					20020				•			
034 71 SBR 079 07 7 124 69 DP 035 52 EE 080 03 3 125 04 04 04 036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 083 03 3 128 69 DP 039 69 DP 084 71 SBR 129 06 06 06 040 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NDP 042 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24		033.:	"02 2			078	02	2				
036 92 RTN 081 02 2 126 43 RCL 037 76 LBL 082 00 0 127 15 15 038 52 EE 083 03 3 128 69 0P 039 69 0P 084 71 SBR 129 06 06 06 040 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NOP 042 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24						079	Ű 07	7% 5				
037 76 LBL 082 00 0 127 15 15 15 038 52 EE 083 03 3 128 69 0P 039 69 0P 084 71 SBR 129 06 06 06 040 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NOP 042 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24										125	. 04 ≹ 04	
038 52 EE					1				. 14	126		
039 69 0P 084 71 SBR 129 06 06 06 000 040 04 04 085 52 EE 130 71 SBR 131 68 NOP 042 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24												
040 04 04 085 52 EE 130 71 SBR 041 43 RCL 086 36 PGM 131 68 NDP 042 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24					100		-					
041 43 RCL					್ವಚಿತ್ರಕ್ಕೆ							
042 04 04 087 11 11 132 43 RCL 043 58 FIX 088 13 C 133 24 24												
043 58 FIX 088 13 C 133 24 24												
그 그 사고 그 그 그 그 그 그 그 그 그 그 그 그 그 그 그 그 그									l			
UTT - UT - UT - 134 - 32. X (
		U44	. 05 0		_ حسند ا	U07_	70	F I A	ا	134	32.X1	نـــــ

Program Data

135 43 RCE	130 26	76	ii. uZi t grapin, gene s — e pri	225 36 PGM
136 25 25	181 - 12			226 26 26
136 25 25 137 61 GTD	182 92			227- 14 D
138 16 A	183 76			228 71 SBR
138 16 A 139 276 LBL	1943842	Dri T		229 68 NOP
140.2.68. NOP	184 43 185 2 69	UD .	4.00	230 - 10 E.
141 44 SUM	186 00	00		231 76 LBL
142 27 27 37	187 02	2.4	•	222 5 14 4 1
143 : 03 - 3	100 800	5		232 14 D 233 403 3
144.607.2	188 ±02 	2	ஆக்க இதுளோதும் ப	234 016 1
145 03 3	190 05			235 42 STD
146 -02 -2	191 / 03	3		236 2175 17
147 03 3	192 07	7		22704.264
148 :07 7	193 00	0		237 04 4 238 - 05 5
149 69 □P·	. 194 00			230 - UJWJ
150 - 04 . 04	195 01			239 42 STD 240 - 23 + 23
151 43 RCL	196 05		•	241 02 2
152 27 27	197 69			242 42 STD
153 69 OP	198 02			_
154 06 06	199 02		-	243 08 08 244 01 1
155 92 RTN	200 04			245 04 4
156 76 LBL	200 04 201 03	2	•	246 42 STD
157 13 C	201 03			247 09 09
158 98 ADV	202 03	1	•	248 87 IFF
159 98 ADV	203 01	÷		249 01 01
160 42 STO	205 02			250 02 02
161 45 45	206 07			251 55 55
162 32 X:T	207 01			252 07 .7
163 42 STO	208 07			253 42 STD
164 31 3F	209 69		•	254 09 09
165 32 X:T	210 03		•	255 75 -
166 71 SBR	211 - 92			256 01 1
167 43 RCL	212.76			25795
168 69 OP	213 - 18	C	٠٠٠	258 5 92 RTN
169 05 05	214 42			259 4.76-LBL
170 58 FIX	215 29			.260 127.B
171 02 02	216 .32		1	261 32 X T- 3
172 43 RCL	217 42		**	262 65 ×
173 45 45	218 30		a seat of the	263 01 1
174 12 B	219 - 32		• •	264 - 00 - 0
175 36 PGM	220 12			265 00 0
176 26 26	221 36			266 95 =
177 11 A	222 26			267 88 DMS
178 12 B	223 13		,	268 92 RTN
179 36 PGM	224 12			269 76 LBL
THE PROPERTY OF THE PROPERTY OF THE PARTY OF	عابر تعج سناتوسعسرا	i ≝. v.⊯./ •/	l	LUS IU LOL

Program Data

The same second is a second se		
270 15 E	315 69 DP	360 95 =
271 42 STO	316 05 05	361 32.XIT
272 12 12	317. 58 FIX	362 01 1
273 97 DSZ	318 404 04 7	363 08 8
274 09 09	319 98 ADV	364 00 0
275 02 ; 02 🚈 🕞	320 43 RCL	365 67 EQ.
276 82 82	321 12 12	366 03 03
277 87 IFF.	322 72 ST*	367. 75:75
278 .02 .02	323 23 23	36894 +/-
2792.19 D	324 32 XIT	369 672 EQ
280 * 61 GTD	325 12 B	
281 - 10-E -	326-36 PGM	
282 01 1	327 26 26	371 - 75% 75
283 - 44 SUM		372 32 XIT
	328 15 E	373 61 GTO
284 172 17	329 22 INV	374 15≸E
285 01 1	330 * 88 DMS	375 86 STF
286 · 44 SUM	331 55 ÷	376 04 04
287 23 23	332 01 1	377 32 X:T
288 97 DSZ	333 00 0	378 94 +/-
289 08 08	334 00 0	379 61 GTD.
290 02 02	335 95 =	380 15 E
291 95 95	336 72 ST*	381 76 LBL .
292 61 GTO	337 17 17	382 10 E.
293 03 03	338 43 RCL	383 43 RCL
294 20 20	339 01 01	384 30 30
295 22 INV	340 32 XIT	385 32 X ∤ T
296 86 STF	341 43 RCL	386 43 RCL
297 04 04	342 12 12	387 29 29
298 22 INV	343 77 GE	388 61 GTD
299 86 STF	344 03 03	389 16 A
300 03 03	345 52 52	390 76 LBL
301 98 ADV	346 - 87 IFF-	391 19 D
302 98 ADV	347 04 04	392 98 ADV
303 5 8 FIX	348 03 03	393 98 ADV
304 02 02	349 52 52	394 - 14 B
305 71 SBR	350 186 STE	395 58 FIX
306 43 RCL	351 03 03	396 04 04
	352 75 -	397 71 SBR
308 03 3	353 01 1	398 43 RCL
309 03 3	354 00 0	
307 03 3 308 03 3 309 03 3 310 02 2 311 03 3	355 87 IFF	
311 03 3	356 03 03	100 00, 10
312 06 6	357 03 03	401 03 3
313 69 OP	358 60 60	402 02. 2.
		403 69 IP
314 04 04	359 94•+/-	404 04 04

Program Data

405	69 OP		424 61	GTO TO		443	10 E.
406	05 05	•	425 04	04		444	92RTN
407	43 RCL	Ì	426 29	29		445	76 LBL
408	27 27	•	427 71	SBR	1	446	44 SUM
409	42 STO	1	428 44	SUM	l	447	61 GTD
410	28 28	1	429 01			448	00 00
411	00 - 0		430 44	SUM		449	03 03
412	42.ST0		431 17				92 RTN
	27. 27		432 - 01	1			.76 LBL
	73 RC*		433 44				371 SBR
	17 17		434 23		• • • • • • • • • • • • • • • • • • • •	450	86 STF
	32 X:T		435 - 97	DSZ			
	73 RC*		436 09	·			-01 -= 01
	23 - 23					455 456	
	97 DSZ			04	1	456	
				14		457	76 LBL
	08 08		439 43	RCL		458	
	04 04		440 28	28		459	86 STF
422***			441 42	- · -		460	02 02
423	11 A	$\mathcal{A}_{i}(A)$	442 27	27	1	461	92 RTN
•		-					

Special Considerations

- The run-stop (R/S) key will stop the program if held down for a few seconds.
- 2. Fifty-four memories are used in the program. The memories used for the totals (TOT) are memory 27 and memory 28. If an incorrect position is entered on A or C' the R/S key should be pressed before the computations are run to save the total memory. The calculator can then be restarted as necessary at A or C'.

the a button todies

- 3. The Great Circle positions (GCP's) run on Label E are based on the Great Circle memories and, when required, should be run immediately after the Great Circle sequence.
- 4. Label D may be pressed at any time between sequences to check the number of GCP's calculator is set to run.
- 5. If an incorrect longitude is entered on E, press R/S until program stops, then press D, enter the correct longitude, and press E.
- 6. The automatic sequence of Mercator for the Great Circle courses may be made to automatically follow the GCP's by pressing SBR GTO before pressing E. The user may then disregard the calculator for several minutes.
- 7. The GCP's run on E will cross the 180° meridian with no adjustment, provided 180 is printed in the sequence.
- 8. The normal six (6) GCP run can be reset at location 252 to any number between 2 and 9.
- 9. The 10° differential on the GCP run can be reset at location 353. It must be in a two digit form such as 05, 10, or 20.

11. When sequencing Great Circles, it is necessary to recall the last position (arrival) for the new departure. As above, press E' then C, etc.

- 12. If a full run on D' (GC CO's) is not anticipated, run D' last, after the final Mercator runs, so as not to lose the primary total memory. If all GC courses are run the memories will automatically transfer.
- 13. When the user intends to start an entirely new Mercator and/or Great Circle sequence, without reloading, the CM's key should be pressed to clear the total memories.
- 14. The program automatically changes decimal minutes in the Great Circle sequences to seconds of arc in the Mercator sequence, and seconds to decimal minutes in the reverse.

Property facilities

